

Quantum Institute Workshop

Quantum Institute Briefing Center; December 9–10, 2002



Research on quantum information theory, quantum computation, decoherence, quantum chaos, Bose-Einstein condensation, and vacuum fluctuations physics.

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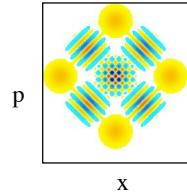
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P. Maia Neto (Rio U.), H. Pastawski (Cordoba U.),
A. Smerzi (Trento U.)



Decoherence

- ✓ Mechanism for quantum-classical transition
- ✓ Interaction between system and environment kills quantum superpositions (Schroedinger cats)

$$\hat{\Pi}_{dec} = \hat{\Pi}_0^{\dagger} \hat{\Pi}_{DB} \hat{\Pi}$$



- ✓ Decoherence and quantum chaos

- *Sub-Planck structure in phase space and its relevance for quantum decoherence,*
W. Zurek, Nature 412, 712 (2001)
- *Unconditional pointer states from conditional master equations,*
D. Dalvit, J. Dziarmaga and W. Zurek, Phys. Rev. Lett. 86, 373 (2001)
- *Quantum chaotic environments, the butterfly effect and decoherence,*
Z. Karkuszewski, C. Jarzynski and W. Zurek, to appear in Phys. Rev. Lett. (2002)
- *Decoherence, einselection and the quantum origins of the classical,*
W. Zurek, to appear in Rev. Mod. Phys. (2003)



Presenter: Diego Dalvit

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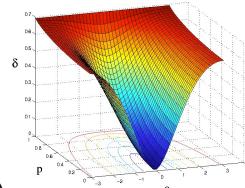
Quantum information

- ✓ Quantum discord as a measure of quantum correlations

$$\mathbb{D}(S, A)_{\{\square_j^A\}} = I(S : A) - J(S : A)_{\{\square_j^A\}}$$

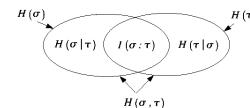
$$H(S) + H(A) - H(S, A)$$

$$H(S) - H(S | \{\square_j^A\})$$



- ✓ Mutual information (gained about an observable // on S in the measurement of an observable // on E)

- ✓ Redundancy of information



- ✓ Continuous quantum measurement with multiple observers

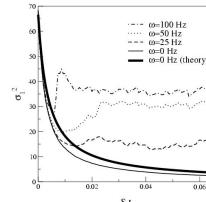
- *Quantum discord: a measure of the quantumness of correlations,,*
H. Ollivier and W. Zurek, Phys. Rev. Lett. 88, 7901 (2002)
- *Quantum discord and Maxwell's demons,,*
W. Zurek, to appear in Phys. Rev. A (2003)
- *Conditional quantum dynamics with multiple observers,,*
D. Dziarmaga, D. Dalvit and W. Zurek, to appear in Phys. Rev. A (2003)
- *Einselection and decoherence from an information theory perspective,,*
W. Zurek, Annlen der Physik 9, 853 (2000)



BEC optics

- ✓ Continuous quantum measurement of BECs as a way to control and engineer the quantum state

Measurement-induced number squeezing $\mathbb{D}_N^2(t) = \sqrt{\frac{\langle N \rangle}{S}}$



- ✓ Schroedinger cat states in BECs

- ✓ Heisenberg-limited interferometry with BECs in optical lattices

- *Measurement-induced squeezing of a Bose-Einstein condensate,,*
D. Dalvit, J. Dziarmaga and R. Onofrio, Phys. Rev. A 65, 033620 (2002)
- *Continuous quantum measurement of a Bose-Einstein condensate: a stochastic GPE equation,,*
D. Dalvit, J. Dziarmaga and R. Onofrio, Phys. Rev. A 65, 053604 (2002)
- *Dynamics of a quantum phase transition in an array of Josephson junctions,,*
J. Dziarmaga, A. Smerzi, W. Zurek and A. Bishop, Phys. Rev. Lett. 88, 7001 (2002)
- *Decoherence in Bose-Einstein condensates: towards bigger and better Schrödinger cats,,*
D. Dalvit, J. Dziarmaga and W. Zurek, Phys. Rev. A 62, 3607 (2000)

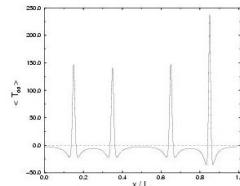


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Vacuum fluctuations

- ✓ Quantum vacuum fluctuations as source for the static and the dynamical Casimir effects

$$\frac{F}{A} = \frac{\pi^2}{240} \frac{\hbar c}{L^4} = 0.016 \frac{\text{dyn}}{\text{cm}^2} \left(\frac{m}{L} \right)^4$$



- ✓ Studies of finite conductivity and temperature corrections
- ✓ Casimir forces in nanotechnology

- *Decoherence via the dynamical Casimir effect,*
D. Dalvit and P. Maia Neto, Phys. Rev. Lett. 84, 798 (2000)
- *Resonant photon creation in a three-dimensional oscillating cavity,*
M. Crocce, D. Dalvit and D. Mazzitelli, Phys. Rev. A64, 013808 (2002)
- *Quantum electromagnetic field in a three-dimensional oscillating cavity,*
M. Crocce, D. Dalvit and D. Mazzitelli, Phys. Rev. A66, 033811 (2002)

